DC-DC circuit **9***a* becomes small by a magnitude of the input voltage Vdc of the DC-DC circuit **9***a*.

[0054] In this way, in the operation of FIG. **7**, there are provided a period when the link voltage Vlink is increased and the input voltage Vdc of the DC-DC circuit **9***a* is increased during a period when the bidirectional DC-DC converter **3***a* is subjected to the through operation in addition to the operation of FIG. **6**. Therefore, the reduction of the switching frequency fsw of the DC-DC circuit **9***a* is suppressed, and the loss in the DC-DC circuit **9***a* is reduced still more.

[0055] In FIG. **8**, the operation in a period c**1** is similar to that in the period a**1** of FIG. **6**. The link voltage Vlink in the period c**1** is determined such that a total efficiency of the DC-DC circuit **9***a* and the bidirectional DC-DC converter **3***a* becomes high. However, the bidirectional DC-DC converter **3***a* is subjected to the through operation so as to transition to a period c**2** before the output voltage Vout reaches the link voltage Vlink in a case where the output voltage Vout increases and the influence of the efficiency reduction of the DC-DC circuit **9***a* due to the increase of the switching frequency fsw of the DC-DC circuit **9***a* when the link voltage Vlink is reduced down to the output voltage Vout becomes smaller than that of the efficiency improvement due to the through operation of the bidirectional DC-DC converter **3***a*. The operations in periods c**3** to c**5** are similar to those in the periods b**2** to b**4** of FIG. **7**.

[0056] In this way, in the operation of FIG. **8**, in addition to the operation of FIG. **7**, the total efficiency of the DC-DC circuit **9***a* and the bidirectional DC-DC converter **3***a* is increased still more by the through operation of the bidirectional DC-DC converter **3***a* before the output voltage Vout reaches the link voltage Vlink.

[0057] Further, in FIG. **7**, when a time slope to increase the input voltage Vdc of the DC-DC circuit **9***a* in the period b**2** is increased, the efficiency may be increased in a case where the input voltage Vdc of the DC-DC circuit **9***a* is increased and also the switching frequency fsw of the DC-DC circuit **9***a* is gradually lowered. In addition, in a case where the switching frequency fsw of the DC-DC circuit **9***a* is too increased in order to reduce the output current Iout in the period b**4**, the efficiency may be increased in a case where the input voltage Vdc of the DC-DC circuit **9***a* is lowered. The situation is the same as that in FIG. **8**.

Third Embodiment

[0058] FIG. **9** is a circuit diagram illustrating a configuration of a power source device **1***b* according to this embodiment. The power source device **1***b* includes an insulated AC-DC converter **2***b* which receives the power of the AC power source **10** and outputs the link voltage Vlink insulated from the AC power source **10** between nodes Nd**11** and Nd**12**, a bidirectional DC-DC converter **3***b* which receives the link voltage Vlink to charge the main battery **5**, and an insulated DC-DC converter **4***b* which receives the link voltage Vlink to supply the power to the load **7**. The insulated AC-DC converter **2***b* includes an AC-DC circuit **8***b* which receives the voltage of the AC power source **10** to output a DC voltage, and a DC-DC circuit **9***b* which receives the DC voltage output by the AC-DC circuit **8***b* to output an insulated link voltage Vlink.

[0059] In the AC-DC circuit **8***b*, there are provided a diode D**15** and a switching element Q**11** which are connected in series to one end of a smoothing inductor L**11** between both ends of the smoothing capacitor C**1**, and a diode D**16** and a switching element Q**12** which are connected in series to one end of a smoothing inductor L**12** between both ends of the smoothing capacitor C**1**. The AC-DC circuit is configured by a bridgeless circuit which receives a current from the AC power source **10** between the other end of the smoothing inductor L**11** and the other end of the smoothing inductor L**12**, and outputs the DC voltage between both ends of the smoothing capacitor C**1**. The AC-DC circuit **8***b* of the bridgeless circuit has a merit on having a high efficiency compared to the AC-DC circuit **8***a* according to second embodiment.

[0060] The DC-DC circuit **9***b* is different from the DC-DC circuit **9***a* according to the second embodiment, in that the resonance capacitor Cr**1** is configured by resonance capacitors Cr**11** and Cr**12**, a half bridge circuit, which is obtained by replacing the switching elements Q**3** and Q**4** and the anti-parallel diodes D**3** and D**4** among the switching elements Q**1** to Q**4** equipped with the anti-parallel diodes D**1** to D**4** connected in bridge using the resonance capacitors Cr**11** and Cr**12**, and in that the diodes D**23** and D**24** among the diodes D**21** to D**24** connected in bridge are replaced with smoothing capacitors C**21** and C**22** respectively. The link voltage Vlink is output between the nodes Nd**11** and Nd**12**. The DC-DC circuit **9***b* is easily simplified compared to the DC-DC circuit **9***a* in which the full-bridge circuit according to the second embodiment is employed.

[0061] The bidirectional DC-DC converter **3***b* includes the smoothing capacitor C**3** which is connected between the terminals Tm**1** and Tm**2**, the switching elements Q**5** and Q**6** which are connected in series between the terminals Tm**1** and Tm**2**, a smoothing inductor L**21** and a switching element Q**8** which are connected in series between both ends of the switching element Q**6**, and a switching element Q**7** and the smoothing capacitor C**4** which are connected in series between both ends of the switching element Q**8**. Both ends of the smoothing capacitor C**4** are used as the terminals Tm**3** and Tm**4**. The link voltage Vlink is connected between the terminals Tm**1** and Tm**2**, and the main battery **5** is connected between the terminals Tm**3** and Tm**4**.

[0062] The bidirectional DC-DC converter **3***b* is configured by an H bridge circuit, and the link voltage Vlink can be controlled to be any voltage regardless of a magnitude relation between the link voltage Vlink and the voltage of the main battery **5**. Of course, when the switching elements Q**5** and Q**7** are fixed to the ON state and the switching elements Q**6** and Q**8** to the OFF state, the through operation can be performed similarly to the bidirectional DC-DC converter **3***a* according to the second embodiment.

[0063] The insulated DC-DC converter **4***b* inputs the link voltage Vlink between both ends of the smoothing capacitor C**5** connected between the nodes Nd**11** and Nd**12**, and supplies the power to the load **7** connected between both ends of the smoothing capacitor C**6**. There is provided a transformer T**11** which magnetically combines the winding N**10** connected to the resonance inductor Lr**10** in series and a winding N**13**. The voltage is applied to the winding N**10** using the voltage of the smoothing capacitor C**5** by the switching elements H**1** to H**4** connected in bridge, the voltage generated in the winding N**13** is applied to smoothing inductors L**32** and L**31** through the diodes DS**1** and DS**2** to cause the current to flow, and the voltage is smoothened by the smoothing capacitor C**6** to be output to the load **7**. The synchronized rectification can be performed in a case where